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Salinity Ranges of the Riga Gulf Invertebrates

by

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The distribution of the bottom fauna in some brackish water bays in the Baltic show that sea bivalves, even if very sensitive to salinity, prefer shallow very brackish zones with fluctuating salinity. Crustaceans which are very sensitive to the gas regime are found in depths of the Riga and Finland Gulfs where there is danger of poisoning.

Many interesting and different opinions have been suggested to explain this. Segerståle (1965) and Yarvekulg (1968) suggest that competition for food between the species is the main reason. They assume that crustaceans feed on the young bivalves (Macoma baltica), etc., forcing them to leave the depths for shallow shore zones.

The authors of this paper attach more importance to physico-chemical factors, in particular salinity, gas regime and especially to the presence of the manganese ion (1968, 1970a and b). In order to explain this interesting phenomenon, they tried to obtain reliable data on the attitude of the bottom invertebrates, first to abiotic factors and then to biotic ones.

This paper presents the results of experimental investigations of the salinity and gas requirements of common invertebrates of the Riga Gulf, adapted to the least saline waters of the Baltic. The work was carried out in the experimental laboratory of BaltNIIRKH, "Asari".

Dreissena polymorpha is a Caspian relic which appeared in the Baltic rivers only a hundred years ago. Nowadays there is a mass occurrence in the rivers Lielooe and Daugava and some others. It is also found in small saline gulfs of other seas. Dreissena is widely spread in the Caspian and Aral Seas where it lives in temperatures ranging from 0 - 28°C and in salinities ranging from 0 (fresh-water) to 10-12‰ (4.2‰Cl) (Karpevich, 1947).

In waterbodies with oceanic connections(the Azovo-Tchernomorsky basin (or Azovo-Black Sea basin)), Dreissena inhabits mainly the estuaries and gulfs with a salinity from 0 to 3‰ and rarely up to 5‰

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(1.6-2.7‰ Cl). In the Baltic it occupies a similar salinity range and inhabits only very bracking regions in the Riga Gulf, the Gulf of Payrnu and some others (salinity from 2 to 3‰, 1.1 - 1.6‰ Cl).

Under experimental conditions with sharp fluctuations in salinity Dreissena survived well in the salinity range of 0-4‰ and in a temperature of 18°C; the respiration rate was stable - 0.015 - 0.02 mg oxygen g/hour. In a salinity of 6‰ the respiration rate decreased to 0.01 mg g/hour and Dreissena died rather quickly. With decreasing water temperature, the tolerance to salinity increases, but a salinity higher than 4-5‰ is unfavourable to the species.

Mya arenaria is a form of marine origin, penetrating to the brackish zones of the Baltic shallow waters. In experimental conditions Mya survived well at a temperature of 20°C and salinities of 0.5 - 1.5‰. The same was observed in salinities of 2.5 - 7.5‰. Removed from water of 5.6‰ (the Riga Gulf) to water of 10‰ or more, the species died. Mya arenaria is not likely to adapt to such sharp fluctuations in salinity, for its widely open shell prevents it from getting isolated in unfavourable conditions. After some acclimatisation, the salinity range for this form can undoubtedly be expanded to higher salt concentrations. For the same reason Mya is highly sensitive to oxygen deficiency, but in the depths of the Riga Gulf where the oxygen content is seldom lower than 4 ml/l the species, as well as the rest of the bivalves, could successfully survive.

Macoma baltica is of marine origin. In the Baltic it usually occupies the shallow shore waters with a salinity of about 6‰. Under experimental conditions, at a temperature of 14-18°C and an oxygen content of about 80%, accompanied by sharp fluctuations in salinity, it survived well in waters from 4 - 25‰ salinity (the Riga Gulf and the North Sea). In fresher water, the body of Macoma started to swell and death rate increased significantly.

Replaced abruptly from a salinity of 5.6‰ (the Riga Gulf) to fresh water and water of 30‰ it died in 3 - 5 days.

Macoma baltica can successfully adapt to oxygen deficiency. It survived for 4 - 5 days with an oxygen content of 0.2-0.25 ml/l, a temperature of 19-20°C and a salinity of 6‰. At lower temperatures (7-10°C) and lower oxygen concentrations, the period of survival was still long. They could survive for 4 - 6 days even in the presence of hydrogen sulphide (up to 2 ml/l).

Cardium lamarcki is a marine form widely distributed in brackish seas of the USSR, such as the Baltic, Black, Azov, Caspian and Aral Seas. In nature it can successfully survive at temperatures from 0 - 25-28°C at rather low salinities of 7-9‰ (4.3-5‰Cl) and at salinities above 40‰ (Sivash).

Under experimental conditions at a temperature of 15-16°C and sharp fluctuations in salinity, it survived successfully in water of 7.5 - 25‰. The respiration was stable (0.01 ml g/hr) and the behaviour was normal. The Riga Gulf water with 5.6‰ salinity was less favourable and the oxygen consumption decreased. The lowest respiration rate was observed in significantly fresher water (0.5-2.5‰) and also in water of high salinity (25‰). It is quite possible that the species, if acclimatised to high salinity, will survive in oceanic waters.

Cardium is highly sensitive to oxygen deficiency. A content of 1.5 to 2 ml/l is unfavourable for the species and a content of 1 - 0.5 ml/l is dangerous, even at low temperatures.

Mesidothea entomon is a brackish water ice relic inhabiting almost all grounds and depths in the Riga Gulf. Significant concentrations were observed at a depth of more than 5m and the largest ones were found at 30-60 m. The species prefer temperatures lower than 10°C but can sometimes survive at 18°C.

Under experimental conditions it was kept at a temperature of 7-10°C and 0-40‰ salinity. M. entomon shows a surprising viability and resistance to changes in the environment. It survived well for 25-48 days in unfavourable salinity ranges. But it still appeared that the Mesidothea which had been adapted to the salinity of the Riga Gulf (5.6‰) survived better than in other cases. In a salinity of 0-2‰ their respiration increased from 0.06 - 0.07 to 0.11 - 0.18 ml g/hour and the death rate increased too. With salinity increasing above 10‰, the respiration rate compared with the control animals increased by 0.5-2 times and remained at that level (0.12 ml g/hour) in a salinity range of 7 - 17‰. A higher death rate was observed in this case. In a salinity above 25‰ respiration and activity of the animals decreased, they stopped shedding and were so to say in "anabiosis" but still alive for 25 days and only in 30-40 days did their death rate increase. In a salinity range of 35-40‰ their survival was low and most of them died during the first 25 days.

Mesidothea can rather well resist a deficiency in oxygen. Under experimental conditions at a temperature of 7-10°C they could live for 1 - 2 days even in the presence of hydrogen sulphide (0.5 ml/l). When this increased to 1 ml/l however, the animals died in 8 hours; in a concentration of 2-3 ml/l they died in 5 - 6 hours. The animals were poisoned to such an extent that ven if they were transferred to normal gas concentrations, they would have died.

Mesidothea is especially sensitive to oxygen deficiency and increases in temperature. A temperature above 15°C (to 23°C) was unfavourable, the animals lost their activity, stopped feeding and died in some days.

The results confirm that all sea bivalves in the Riga Gulf prefer the brackish shallow waters. Decrease in salinity by 1 - 2 ‰ is dangerous to them. The depth of the Gulf with a higher and more constant salinity are more favourable for these animals. A somewhat decreased oxygen content does not have unfavourable effects on them (especially Macoma baltica).

Mesidothea entomon can easily survive in strongly brackish water and in a salinity of 1-2‰, but the high temperatures are not suitable for them which occur in the shallow zones, they prefer the cold deep regions of the Gulf.

For the species studied the feeding conditions in the shallow zones are good. For a predator like M. entomon shallow shore zones inhabited by bivalves are excellent feeding grounds, but their abundance there is very low. On the other hand, their abundance increases highly at depths which are poor in food reserves. This distribution may possibly be explained by the favourable temperature regime and absence of competitors.

As far as the bivalves are concerned, we are unable to suggest any reason why they avoid depths. The problem will be discussed in further papers.

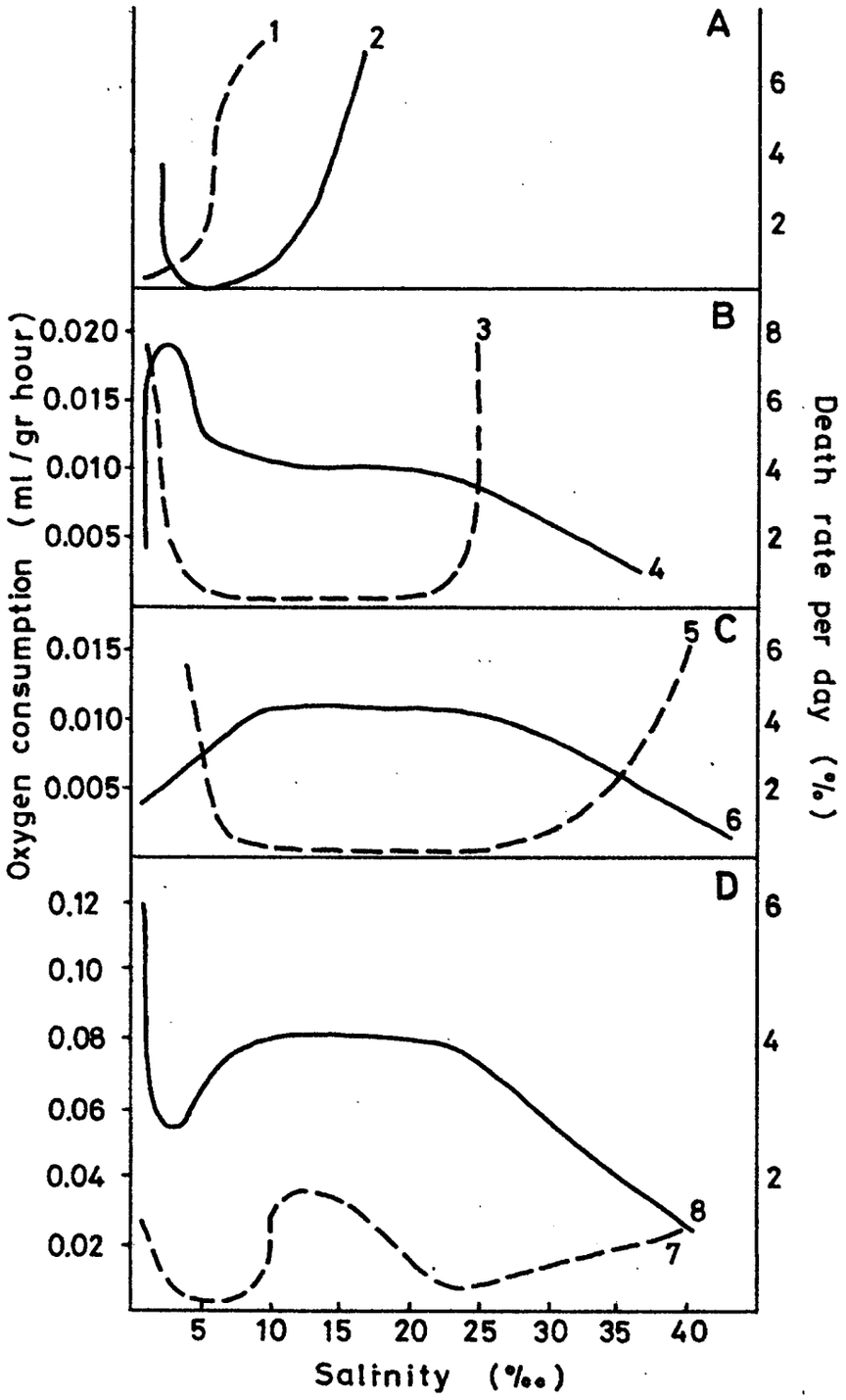

Figure 1. The animals were replaced from the Riga Gulf water (6‰ S) to dissoluted water of the North Sea with a temperature of 18-18°C.

A,1 - Dreissena polymorpha

A,2 - Mya arenaria

B - Macoma baltica

C - Cardium lamarcki

D - Mesidothea entomon

1, 3, 5 and 7 - average daily death rate

2, 4, 6 and 8 - oxygen consumption (ml per gram of body weight during 1 hour).